Speed, Velocity, and Acceleration

1) What is the speed of a rocket that travels 9000 meters in 12.12 seconds?

$\Delta d = 9000m$
$\Delta t = 12.12s$
$v = ?$

$v = \frac{\Delta d}{\Delta t}$

$v = \frac{9000m}{12.12s}$

$v = 742.57\ldots\ m/s$

$v \approx 700\ m/s$

2) After an impact involving a non-functioning satellite, a paint chip leaves the surface of the satellite at a speed of 96 m/s. After 17 seconds, how far has the chip landed?

$v = 96\ m/s$
$\Delta t = 17s$
$\Delta d = ?$

$v = \frac{\Delta d}{\Delta t}$

$v\Delta t = \Delta d$

$\Delta d = 96\ m/s\ (17s)$

$\Delta d = 1632m$

$\Delta d \approx 1600m$

3) The space shuttle Endeavor is launched to altitude of 500,000 m above the surface of the earth. The shuttle travels at an average rate of 700 m/s. How long will it take for Endeavor to reach its orbit?

$\Delta d = 500000m$
$v = 700\ m/s$
$\Delta t = ?$

$v = \frac{\Delta d}{\Delta t}$

$\Delta t = \frac{\Delta d}{v}$

$\Delta t = \frac{500000m}{700\ m/s}$

$\Delta t = 714.286\ldots s$

$\Delta t \approx 700s$

4) How many seconds will it take for a satellite to travel 450 km at a rate of 120 m/s?

$\Delta t = ?$
$\Delta d = 450km = 450000m$
$v = 120\ m/s$

$v = \frac{\Delta d}{\Delta t}$

$\Delta t = \frac{\Delta d}{v}$

$\Delta t = \frac{450000m}{120\ m/s}$

$\Delta t = 3750s$

$\Delta t \approx 3800s$

5) How far (in meters) will you travel in 3 minutes running at a rate of 6 m/s?

$\Delta d = ?$
$t = 3min = 180s$
$v = 6\ m/s$

$v = \frac{\Delta d}{\Delta t}$

$\Delta d = v\Delta t$

$\Delta d = 6\ m/s\ (180s)$

$\Delta d = 1080m$

$\Delta d \approx 1000m$

6) The space shuttle releases a space telescope into orbit around the earth. The telescope goes from being stationary to traveling at a speed of 1700 m/s in 25 seconds. What is the acceleration of the satellite?

$V_1 = 0\ m/s$
$V_2 = 1700\ m/s$
$\Delta t = 25\ s$
$a = ?$

$a = \frac{\Delta V}{\Delta t}$

$a = \frac{1700\ m/s - 0\ m/s}{25\ s}$

$a = 68\ m/s$

7) A motorcycle stuntman accelerates from rest to a maximum speed of 35.2 m/s at the top of the take-off ramp, and then swoops up and over 20 cars. Calculate how long it takes him to accelerate, at an acceleration of 8.8 m/s^2.

$V_1 = 0$
$V_2 = 35.2\ m/s$
$a = 8.8\ m/s^2$
$\Delta t = ?$

$a = \frac{\Delta V}{\Delta t}$

$\Delta t = \frac{\Delta V}{a}$

$\Delta t = \frac{35.2\ m/s - 0\ m/s}{8.8\ m/s^2}$

$\Delta t = 4.0\ s$

8) A car accelerates from rest to 8.8 m/s in 3.0 s in first gear then changes into second gear. After 8.0 s from the start of the trip, the car reaches 22.0 m/s and is shifted into third gear. After 7.0 s in third gear, it reaches 41.8 m/s. Calculate the acceleration in each gear.

1st

$\vec{a}_1 = \frac{8.8\ m/s - 0\ m/s}{3.0\ s - 0\ s}$

$\vec{a}_1 \approx 2.9\ m/s^2$

2nd

$\vec{a}_2 = \frac{22.0\ m/s - 8.8\ m/s}{8.0\ s - 3\ s}$

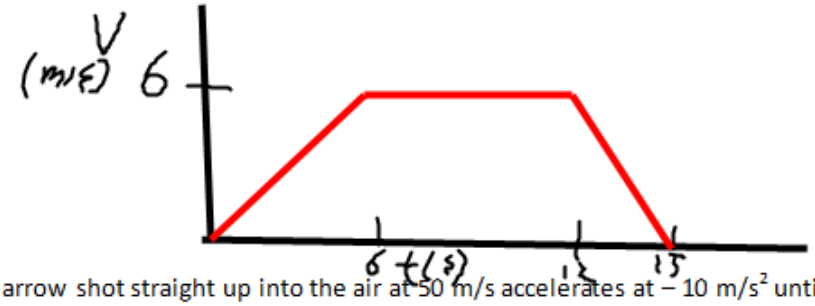
$\vec{a}_2 \approx 2.6\ m/s^2$

3rd

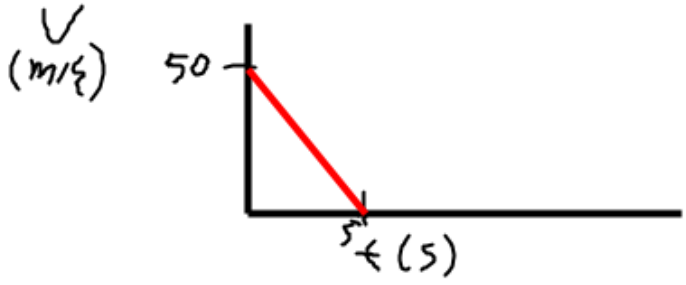
$\vec{a}_3 = \frac{41.8\ m/s - 22.0\ m/s}{7.0\ s}$

$\vec{a}_3 \approx 2.8\ m/s^2$

9) Sketch the speed-time graph for the motion of a bus that accelerates from rest at 1.0 m/s^2 for 6.0 s, then continues on at a constant speed for 6.0 s, then accelerates at – 2.0 m/s^2 for 3.0 s.



10) An arrow shot straight up into the air at 50 m/s accelerates at – 10 m/s^2 until it stops. Sketch the speed-time graph of the motion.



11) A train slows down from 50.0 m/s [E] to 34.0 m/s [E] in 4.0 s. What is its acceleration?

$\vec{v}_1 = 50.0\ m/s$

$\vec{v}_2 = 34.0\ m/s$

$\Delta t = 4.0\ s$

$\vec{a} = ?$

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

$\vec{a} = \frac{34.0\ m/s - 50.0\ m/s}{4.0\ s}$

$\vec{a} = -4.0\ m/s^2$

or $4.0\ m/s^2$ [W]

12) A ball rolling up a ramp has an initial velocity of 5.0 m/s. 4.0 s later, it has a velocity down the ramp of 3.0 m/s. Calculate

a. the acceleration.

$\vec{v}_1 = 5.0\ m/s$

$\vec{v}_2 = -3.0\ m/s$

$\Delta t = 4.0\ s$

$\vec{a} = ?$

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

$\vec{a} = \frac{-3.0\ m/s - 5.0\ m/s}{4.0\ s}$

$\vec{a} = -2.0\ m/s^2$

b. When the ball was stationary.

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

$\Delta t = \frac{\Delta \vec{v}}{\vec{a}}$

$\vec{v}_2 = 0\ m/s$

$\Delta t = \frac{0\ m/s - 5.0\ m/s}{-2.0\ m/s^2}$

$\Delta t = 2.5\ s$

13) A ball rolls up a hill, starting at 10.0 m/s, and accelerates at -3.0 m/s^2 [up]. What is the velocity after:

a. 1.0 s

$v_1 = 10.0\ m/s$

$v_2 = ?$

$\vec{a} = -3.0\ m/s^2$

$\Delta t = 1.0\ s$

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$

$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$

$\vec{a}\Delta t = \vec{v}_2 - \vec{v}_1$

$\vec{v}_2 = \vec{a}\Delta t + \vec{v}_1$

$\vec{v}_2 = (-3.0\ m/s^2)(1.0\ s) + 10.0\ m/s$

$\vec{v}_2 = 7.0\ m/s$

b. 3.0 s

$\Delta t = 3.0\ s$

$\vec{v}_2 = \vec{a}\Delta t + \vec{v}_1$

$\vec{v}_2 = (-3.0\ m/s^2)(3.0\ s) + 10.0\ m/s$

$\vec{v}_2 = 1.0\ m/s$

c. 4.0 s

$\Delta t = 4.0\ s$

$\vec{v}_2 = \vec{a}\Delta t + \vec{v}_1$

$\vec{v}_2 = (-3.0\ m/s^2)(4.0\ s) + 10.0\ m/s$

$\vec{v}_2 = -2.0\ m/s$

or $2.0\ m/s$ [down]

14) Below is a speed-time graph of a bicycle.

a. How fast is the bicycle moving at each of the following times?

i. 4 s: 4 m/s

ii. 6 s: 6 m/s

iii. 10 s: 3.3 m/s

iv. 12 s: 2 m/s

b. What is the acceleration of the bicycle at each of these times?

i. 2 s

slope:

$\vec{a} = 0\ m/s^2$

(horizontal line)

ii. 5 s

slope:

$\vec{a} = \frac{6\ m/s - 4\ m/s}{6\ s - 4\ s}$

$\vec{a} = 1\ m/s^2$

iii. 7 s

slope:

$\frac{2\ m/s - 6\ m/s}{12\ s - 6\ s}$

$\vec{a} \approx -0.7\ m/s^2$

iv. 14

slope:

$\frac{5\ m/s - 2\ m/s}{16\ s - 12\ s}$

$\vec{a} \approx 0.75\ m/s^2$